ELLIPSOIDAL LAVAS IN THE GLACIER NATIONAL PARK, MONTANA[1]

LANCASTER D. BURLING
Geological Survey, Ottawa, Canada

The paper by Capps on "Some Ellipsoidal Lavas on Prince William Sound, Alaska,"[2] recalls to my mind a similar occurrence which I visited in 1907. The locality is now so accessible and the flow is so clearly subaqueous in character that a brief description of it may be of interest. Its outcrop appears in the ridge (Shepard Mountain) northeast of Flattop Mountain, Glacier National Park, Montana, and the features described are in that portion of the bed which overlooks the Shepard Glacier. The lava, to which the name Purcell lava has been commonly applied, interrupted the sedimentation of a flat-lying, greenish argillite which forms the uppermost part of the Siyeh formation of the pre-Cambrian. This argillite lies in normal position, and the portions above and below the lava bed are macroscopically identical.

The Purcell lava is approximately 150 feet thick on Shepard Mountain and can be traced for miles to the southeast, north, and northwest. It is composed of six or more successive flows, each of uneven and more or less ropy surface, separated by small and more or less local accumulations of shale. The lower 25 or 30 feet of the flow is composed of a conglomeration of dense, homogeneous, spheroidal masses averaging 1 to 2 feet in diameter. They preserve their shape in the lower layers, being separated from each other by chert or drusy cavities, and many individuals have displaced considerable portions of the mud upon which they were rolled or shoved, even to the extent of complete burial. The bottom of the flow is therefore exceedingly irregular. Toward the top of this bed the individual spheroids yield more or less to the

[1] Published by permission of the Deputy Minister of Mines.

[2] *Jour. Geol.*, XXIII (1915), 45–51.

pressure of their fellows, and they unite to form an upper surface of moderate unevenness. The upper part of the entire flow is composed of a bed about 20 feet thick, which, though massive in character, is very porous. Vesicles are common near the base of several of the individual flows in the lower portion of the lava.

On Mount Grinnell, 10 miles to the southeast, Finlay[1] gives the thickness of the lava bed as 42 feet, but does not mention the ellipsoidal masses which Daly later describes from the same locality.[2] Finlay records the discovery of five genetically connected dikes on Flattop Mountain close to the localities where the ellipsoids are present. Elsewhere, though the lavas reached the surface through numerous widely scattered dikes, ellipsoidal structure has not been recorded. This period of igneous activity has been described[3] as having genetically connected extrusive and intrusive phases, and it is interesting to note that strata, upon whose upper subaqueous surface lava was being extruded, should have been able, at a depth of only 600 feet, to accommodate themselves to the essentially contemporaneous intercalation, along single planes, of intrusive sills scores of square miles in extent.

This flow seems to afford an excellent opportunity for determining the value of certain criteria for distinguishing (1) subaerial from subaqueous flows, and (2) the top from the bottom of subaqueous flows. Here the normal attitude of the flow and its including sediments is unquestionable, and the bottom of the bed in which the ellipsoidal structure is developed is far more uneven than the top, an observation which lessens the importance of one of the criteria advanced by Capps. Furthermore, the silting up of cracks in the surface of the flow would seem more natural than the upward penetration, into cracks several feet in height, of mud sufficiently resistant to flatten the bases of individual ellipsoids. That the latter is true for the Prince William Sound locality[4] merely illustrates the difficulty of obtaining competent and unconflicting criteria.

[1] *Bull. Geol. Soc. America*, XIII (1912), 350.

[2] *Memoir Geol. Survey Canada*, No. 38, Part I (1912), p. 217.

[3] Daly, *ibid.*, pp. 218–20.

[4] Capps, *Jour. Geol.*, XXIII (1915), 49.

So far as the Glacier National Park exposure of the Purcell lava is concerned, the following criteria would seem to indicate the bottom of a subaqueous flow: (1) discreteness of the basal spheroids and their relative competence to resist mashing; (2) comparative unevenness, with reference to the top; (3) the irregular displacement of the underlying shale by the basal spheroids; and (4) the presence of vesicles near the base of the individual flows. Criteria indicating the top are: (1) the common ropy structure; (2) more or less complete fusion of the individual spheroids; (3) comparative evenness, with reference to the bottom; (4) silting up of hollows in the top by strata whose laminae parallel those of the adjacent strata; and (5) the absence of vesicles in the upper portions of the individual flows.

The flow under discussion covers an area hundreds of square miles in extent, and while its extrusive character has been recognized by various observers, the ellipsoidal structure has only been found at the localities described. It may have been subaqueous in places, subaerial in others (the Siyeh argillites are abundantly ripple-marked and sun-cracked in places), but many lines of evidence seem to prove its subaqueous character at the locality described, and indicate that ellipsoidal structure is a competent criterion of subaqueous extrusion.